How to design a cost-effective policy of wetland selection for water quality preservation in agricultural landscape?

Elsa Martin

Elsa Martin, Agrosup Dijon, France

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Wetlands are the interface between land and water – simultaneously providing benefits and imposing costs on local communities. On the one hand, water percolates through wetlands, providing a cleaning process beneficial to society.[3] This cleaning process is particularly important in agricultural landscape where pollution from pesticides or nutrients are widespread. Yet, on the other hand, wetlands are costly for agricultural production since they are unproductive land.

The consequence is that without a public policy implementation, wetlands are often drained by private owners. This phenomenon is induced by what is classically known in environmental economics as a divergence between private costs (agricultural costs of wetlands) and social costs (costs of water pollution). A public policy is required in order to preserve wetlands and hence water quality, particularly in agricultural landscape. The question is, which wetlands should be prioritized for protection?

Whereas most of studies focus on large wetlands which are easy to identify [3], focusing on small wetlands that are scattered across landscape is more insightful when considering an agricultural landscape.[1,2] However, in a world with limited budget for policy-makers, it is necessary to value both the effectiveness of those small scattered wetlands for water quality preservation and their costs to design a cost-effective public policy. These crucial points require both environmental science (for effectiveness valuation) and economics (for cost valuation). [1,2]

I illustrate both the effectiveness and the cost valuation aspect of small scattered wetlands selection. I conclude with some policy implications for wetlands and water quality preservation in agricultural landscape.

The effectiveness valuation of small scattered wetlands for water quality preservation

Two main sources of water pollution are at work in agricultural landscapes: pesticides and nutrients. In France, pesticide pollution is mostly widespread in water catchments which are characterized by grape production,[2] whereas nutrient pollution is widespread in water catchments which are characterized by animal production, such as meadows and cereal crops [1]. Artificial Wetlands (AW) are a specific type of wetland useful for grape production landscape [2] whereas Valley Bottom Wetlands (VBW) are useful in animal production landscape [1].

AW are constructed wetlands, generally in a pre-existing storm basin. They replicate the natural process of water cleaning induced by soil and vegetation of wetlands. Following works from environmental science, the assimilative capacity of AW can be assumed as being a function of both the volume of the gravel filter (which increases water residence) and of the mass of pesticide.[2]

VBW are mainly natural wet meadows. The identification of these VBW at the water catchment level is not trivial. In line with French legislation on wetlands, it is possible to base this identification on the hydromorphy characteristic of soil. A two-step method on the basis of soil science results can be developed: firstly, topographic indices are computed with geographical information system tools and secondly, local threshold values of these indices are defined on the basis of field measurements.[1]

The exact quantification of VBW effectiveness is not obvious because VBW are small and scattered across landscape. This problem can be overcome through the construction of a classification of different types of VBW, on the basis of the environmental science literature results. VBW are then distinguished in increasing effectiveness according to whether they are unconnected, connected downstream, connected upstream on impermeable parent material and connected upstream on permeable parent material.[1]

The costs valuation of preservation

Once the effectiveness of wetlands approximated, the costs of preservation become essential to design cost-effective policies of preservation.

The cost of VBW conservation can be approximated with the estimation of their purchase costs, i.e. the market price of undeveloped land. To do so, two steps are required: firstly, a price model of lands sold in the market on the basis of observed real-estate transactions needs to be estimated and secondly, the price of all lands (even the ones that were never sold) located on the water catchment under study can be predicted.[1]

The main challenge is to make soil science and economics scale of analysis compatible. Indeed, VBW are located and their effectiveness approximated at the scale of soil units, whereas the cost of preservation relies on an administrative scale of land transactions. Working at the administrative plot scale which is sufficiently small to match with soil units is the solution.[1]

Usually, AW are already the property of policy-makers and the main part of the cost is their construction costs. This cost can be assumed to be composed of two parts: one part that is fixed because of being composed of an investment cost for a gabion barrier construction and one other part that is function of the volume of gravel put into the AW.[2]

Policy implications

The main policy implication is that small scattered wetlands are important to preserve or to construct for water quality preservation in agricultural landscapes. Wetlands are usually located upstream in the hydrologic network i.e. they are located in the bottomlands of the headwater watershed; the consequence is that they have a strong influence on hydrology downstream. Furthermore, small wetlands are strongly influenced by runoff from agricultural land use, which means that they can considerably affect water quality.

French water agencies purchase land to protect water. In this situation, an analysis of the criteria of wetland selection to be implemented to achieve a water quality preservation goal is needed. In an ideal world without budget constraints, a classification of wetland effectiveness based on environmental science literature is the best criterion to be used. However, when the budget of the policy maker in constrained, it is of high importance to simultaneously consider effectiveness and cost criteria. Indeed, concentrating on either effectiveness or cost separately can considerably reduce the impact on water quality preservation for a given budget. Policy makers must also be alerted to the need of caution surrounding the mean per-hectare cost criteria of selection since it can hide local disparities.[1]

Finally, wetlands cannot be the only regulation instruments to be used to improve water quality in agricultural landscape and must be considered as supplemental instruments to input charges for instance. For the combination of instruments to be cost-effective, the cost for improving effectiveness in one additional unit (the marginal cost) must be the same for each instrument.[2]

References

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Elsa Martin is assistant professor in environmental economics applied to the agricultural sector at AgroSup Dijon. She made her PhD at Aix-Marseille University on the economics of groundwater management in irrigated areas. She has extended her PhD to the economics of water quality preservation focusing on land-use management since her recruitment at Agrosup Dijon.